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REPORT

of the

Army Field Forces

Board No. 3

FORT BENNING, GEORGIA

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Project No. 2219

RECOILLESS WEAPONS CONFERENCE, 20 DECEMBER 1948

Date 7 April 1949

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CSGLD/F3

2 Aug 1949

SUBJECT: Recoilless Weapons Conference

TO: Chief, Army Field Forces
Fort Monroe, Virginia
Attention: ATDEV-11

1. Reference letter, subject: "Army Field Forces Board 3 Report of Project 2219, Recoilless Weapons Conference, 20 December 1948", ATDEV-11 472/25(c) (18 July 1949).

2. Recommendations contained in paragraphs 4a and h of above referenced letter are approved with a priority of 1C. A priority of 1B cannot be justified for these items.

3. Recommendations contained in paragraphs 4b, d, e, g, i, k, l, m, n and o, of above referenced letter, are approved.

4. An expression of interest as requested in paragraph 4c, above referenced letter, has previously been made to the Canadian government. The Chief of Ordnance will furnish information made available to him on the progress of development as it is provided by the Canadian government.

5. Approval is withheld on the recommendation contained in paragraph 4f, above referenced letter. The cartridges listed are now standard and no further manufacture of this particular type is contemplated. In view of this it is not deemed economical to modify any of these items for test by Army Field Forces Board No. 3.

6. A copy of the 1st Indorsement to the above referenced letter forwarding subject report to the Chief of Ordnance is attached as an inclosure.

BY ORDER OF THE SECRETARY OF THE ARMY:

Signed by E. L. Cummings
Col., GSC

C. G. HELMICK
Major General, GSC
Deputy Director for
Research and Development
Logistics Division

1 Incl
1st Ind fr D/L
to CofOrd(cy)

Copy furnished:
Wash. Dep., Dev. Sec., AFF

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OFFICE, CHIEF, ARMY FIELD FORCES
Fort Monroe, Virginia

ATDEV-11 472/25(C) (18 Jul 49) 18 July 1949

SUBJECT: Army Field Forces Board No. 3 Report of Project No. 2219, "Recoilless Weapons Conference, 20 December 1948"

TO: Director of Logistics
General Staff, United States Army
Washington 25, D. C.
ATTENTION: Research and Development Group

1. Forwarded herewith are five (5) copies of report of Army Field Forces Board No. 3, Project No. 2219, dated 7 April 1949, subject: "Recoilless Weapons Conference, 20 December 1948."

2. The recommendations contained in paragraph 4 of this report are concurred in except as is noted in paragraphs 5 and 6 of this letter. The Chief of Ordnance has already taken steps to implement a number of the approved recommendations in whole or in part.

3. The British and Canadian Liaison Officers on duty with this Office had no comments.

4. It is requested that the proper agency be directed to implement the following recommendations and that this Office be informed of the action taken so that military characteristics may be provided where necessary:

a. That the current development of the Rocket, 2.36 inch, T59 series, be continued with Priority 1B.

b. That development work to improve the penetration on sloping armor, the accuracy and temperature range of the 3.5 inch rocket (M28) be continued with a priority of 1B.

c. That interest be expressed to the Canadian government in the early development of the Heller Rocket and that Army Field Forces be kept informed of the progress of such development.

d. That fin stabilized and spin compensated HEAT shells suitable for use in the 90mm Tank Gun and the 75mm Recoilless Rifle, M20, be developed with a priority of 1C. (Military characteristics for the latter shell to be submitted if desired.)

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✓ approved by Log. Div.

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ARMY FIELD FORCES BOARD NO. 3 Ref No B/22/39
Fort Benning, Georgia

21 February 1949

The President
Army Field Forces Board No. 3
Fort Benning, Georgia

SUBJECT: Recoilless Weapons and Rocket Development

Ref Recoilless Weapons Conference on 8, 9 Dec and 21 Dec 1948. The War Office has the following comments:-

"1. 75mm
It appears that the redesigned M.310 projectile for the 75mm recoilless rifle, both spin and fin stabilized, would fall short of our armour penetration requirement, though in the case of the fin stabilized projectile armour penetration of 225mm at 90 degrees may be achieved, though accuracy is almost certain to suffer.

2. 105mm
Although a spin stabilized projectile fired from a 105mm recoilless rifle may meet penetration, range and accuracy requirements for a Bn anti-tank weapon, the fact that the weapon (285 lbs) would not be manportable is a major disadvantage, and for this reason we would be opposed to it. It is possible, however, that the weapon could be broken down into two or more parts in order to allow it to be manportable for short distances. Therefore, although we agree with the opinion expressed by the British Liaison Officer, we consider that the recommendation in Appendix "C", Para 9, of the Summary of Recoilless Weapons Development, to continue development of the 105mm lightweight recoilless rifle on a higher priority than the 75mm recoilless rifle, is sound.

3. 57mm
It does not appear that a projectile for the 57mm recoilless rifle, either spin or fin stabilized, could be produced which will meet the armour penetration requirement for a Platoon anti-tank weapon. Furthermore, as the weapon to fire this projectile is likely to exceed our maximum weight requirement for a platoon anti-tank weapon, we consider that the development of the 57mm projectile is not of major importance.

4. Heller Rocket
The recommendation in Appendix "C", Para 5, (Summary of RCL Weapon Development) regarding the Heller Rocket is agreed; we are keeping in touch with Canada regarding this development.

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"5. Sights for 75mm and larger recoilless weapons

Indirect sighting is not required for use in the anti-tank role, though the ability to fire indirect may be most useful in other roles. We agree, therefore, with the recommendations that sights for 75mm and larger recoilless weapons be provided for use in both direct and indirect fire, provided the effectiveness of the sights for use in the anti-tank role is not prejudiced."

/s/ F. A. H. Ling
F. A. H. LING, Lt. Colonel
British Infantry Liaison Officer

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BASIC: Ltr, AFF Bd No 3, Ft Benning, Ga, GNBCG 472, "Recoilless Weapons Development", dated 5 Jan 49.

AIDIT 461 1st Ind. January 27, 1949

HEADQUARTERS, Fort Knox, Kentucky

TO: President, Army Field Forces Board No. 3, Fort Benning, Georgia

1. Report of the Army Field Forces Board No. 3 Recoilless Weapons Conference dated 20 December 1948 is concurred in with the following exceptions:

a. Paragraph 2a and 2b, Tab B, Discussion and Recommendations:

(1) A lightweight, easily transported weapon that will fulfill the desired mission is the weapon needed. The breakdown type lightweight 105mm recoilless gun requires a large crew for transport and service. Due to the weight of this weapon it is not easily transported. Paragraph 2a does not conclusively state that the lightweight 75mm cannot be improved so as to meet the necessary requirements.

(2) Recommend that the development of the 105mm recoilless material and ammunition be continued with priority 2A.

b. Paragraph 4j, Tab B, Discussion and Recommendations:

(1) Do not concur for reasons outlined above.

(2) Recommend that a 75mm Recoilless Rifle, weighing not over 75 pounds and suitable ammunition be developed with a 1B priority.

2. Inclosure was withdrawn for information and file.

FOR THE COMMANDING GENERAL:

/s/ J. Kocknavate
J. KOCHNAVATE
Lt. Col., A.G.D.
Adjutant General

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ARMY FIELD FORCES BOARD NO. 3, 20 DECEMBER 1948

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SUMMARY OF RECOILLESS WEAPONS DEVELOPMENT
(Based upon data available at AFF Board No. 3, 20 Dec 1948)

1. 57mm

a. A pilot model of the T66 Lightweight 57mm Recoilless Rifle will be completed about June 1949. It will weigh approximately 25 pounds complete with accessories. It will fire present standard projectiles at 1200 f/s m.v. but will require a new tapered cartridge case, which is also under development. The armor penetration of this projectile will be the same as the present standard HEAT shell, i.e. 3.5 inches at 90° impact. This armor penetration can be increased to 4.4 inches by the use of composition B and a copper cone.

b. A fin stabilized projectile could be designed for use in this rifle. It would have a muzzle velocity of about 1000 f/s and would have an armor penetration at 90° of approximately 6.7 inches. The probable error at ranges up to 500 yards should not exceed 1 mil. This is based largely on statements of Mr. Sergo J. Zaroodny of BRL, who has conducted research in the field of fin stabilized projectiles. (See BRL Memo Report No. 333 dated 27 September 1944).

2. 75mm

a. Cartridge, HEAT, 75mm, M310

With Comp B and a copper cone we can expect a 25% increase in armor penetration. This will increase the penetration from 4.5 inches at 90° to 5.6 inches at 90°. (A possible increase over 25% may be expected if the composition B loading technique is developed).

b. By redesigning the shell, i.e. decreasing the thickness of the shell wall slightly and increasing the size of the cone slightly and using Comp B and a copper cone, a further increase in penetration may be expected. The most optimistic amount of penetration that may be expected with this combination will be approximately 5.8 inches.

c. By using the fluted cone in the shaped charge of the spin stabilized shell the maximum armor penetration that may be expected by applying this principle to the present shell will be about 7.3 inches at 90°. With the redesigned shell mentioned in the preceding paragraph the maximum armor penetration that may be expected by applying this principle will be about 7.65 inches at 90°. This is based on the statement from OCO that the optimum penetration which may be expected of the fluted cone will be 75% of a fin stabilized shell of the same caliber.

d. By using a fin stabilized shell in the 75mm rifle, the maximum armor penetration which may be expected will be about 9 inches. This is based on the fact that the 3.5 inch rocket, which has Comp B and a copper cone will penetrate 10-12 inches of armor at 90°. Using 11 inches as an average for this rocket and applying a direct ratio between the caliber of 3.5 inches and 75mm, we arrive at the figure slightly more than 9 inches, which is the maximum amount of armor penetration which may be expected with a fin stabilized shell of 75mm caliber.

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e. It is to be expected that the accuracy to be attained with a fin stabilized shell will be considerably less than that to be obtained with a spin stabilized shell.

3. 105mm.

a. The present armor penetration of the spin stabilized 105mm HEAT shell is 5.75 inches at 90°. This is the standard HEAT Shell, M67 using steel cone and Pentolite loading. By using Comp B and copper cone an armor penetration of 7.2 inches at 90° may be expected.

b. In 1944 a fin stabilized HEAT shell (assumed to be Pentolite loaded and using a steel cone) was fired at Aberdeen from a conventional 105mm Howitzer. A penetration of 10.5 inches at 90° was obtained. By using Comp B and a copper cone in this shell, a penetration of 13.1 inches at 90° may be expected.

c. The shell fired at Aberdeen had a muzzle velocity of approximately 1500 f/s and had a probable error of 1/2 mil in both elevation and deflection at ranges up to 1000 yards. Beyond this range the accuracy fell off rapidly, apparently due to the fact that stability of the projectile deteriorated as the velocity passed through the speed of sound.

d. If the fluted cone principle can be applied to this shell the penetration at 90° may be expected to be 11.1 inches. A considerable increase in accuracy over the fin stabilized shell can be expected. Such a shell appears to more nearly meet the requirements of accuracy, range, and penetration as set up at the AT Defense Conference than any other. It meets the penetration and range requirements in full; the accuracy should be more nearly met than with the 75mm recoilless. The weight of the weapon will exceed that which may be man portable, but a compromise may have to be effected on this point. It is expected that such a weapon could be easily mounted and fired from a ¼ ton truck.

e. Based on the fact that with the 75mm HEAT shell we can decrease the weight of the HEAT shell by 36%, it is assumed that a comparable reduction can be made in the 105mm HEAT shell, which is similar in design to the 75mm HEAT shell. This would result in a fin stabilized 105mm HEAT shell weighing about 20 pounds. The muzzle velocity of this fin stabilized, HEAT shell should be about 1020 f/s in order to avoid exceeding the speed of sound, thereby keeping the shell stable.

f. Taking advantage of the decrease in projectile weight, a new lightweight recoilless gun could be designed to fire this lighter weight projectile which would not exceed 285 pounds in weight.

g. Based on performance of the T59 rocket, which has a probable error of 1.2 mils at 500 yards, and the Aberdeen BRL results with the 105mm fin stabilized HEAT shell, which had a .5 mil probable error up to 1000 yards, it is estimated that the probable error of the 20 pound fin stabilized projectile with a MV of 1020 f/s will not exceed 1 mil at ranges up to 2500 yards. This is to be expected since the maximum range of this projectile should be over 6000 yards and the projectile should maintain its stability at least to 2500 yards range.

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4. Rockets:

a. The 2.36" T59 HEAT Rocket now under procurement for engineering and service test weighs 6.8 pounds, has a M.V. of 440 f/s, penetrates 7 inches of armor at 90° impact, and has a probable error of 1.2 mils at 500 yards. It will be fired from the standard M18 2.36" Rocket Launcher. It employs a copper cone and composition B loading.

b. The 3.5 inch M28 HEAT Rocket now under procurement weighs 8.5 pounds, has an M.V. of 335 f/s, penetrates 11 inches of armor at 90° impact, and has a probable error of 2 mils at 300 yards. It will be fired from the standard M20 Rocket Launcher. It employs a copper cone and composition B loading. Further development of the rocket is about to be initiated to improve armor penetration on sloping armor, accuracy and temperature range.

c. This board, with the advice of the OCO, proposed the development of a 16 pound rocket and launcher therefor. This rocket would penetrate 11 inches of armor at 90° impact, have a maximum range of at least 2000 yards, and would insure 50% hits on a target the size of a tank at 1000 yards. This rocket would resemble the T59 rocket in design.

d. The launcher for this rocket would weigh approximately 40 pounds including a 2 piece tube 90 inches long and tripod mount.

e. The Heller Rocket, designed by the Canadian government and copied from the German Hammer Rocket, is in an advanced design stage. The characteristics of this rocket are as follows: The caliber is 3.2 inches, weight of launcher estimated at 35 pounds, velocity 900 f/s, weight of rocket approximately 8.5 pounds, armor penetration 10 inches, accuracy estimated by the inventor as ½ mil probable error up to 1000 yards.

5. A.D. Little Report

a. The Arthur D. Little Report proposed three designs of Recoilless Weapons.

b. The first design employs a venturi in the cartridge case. The weapon would weigh 25 pounds and fire a fin stabilized projectile at 900 f/s. The armor penetration expected is 9 inches. The estimated time for development of a pilot model is 2 years. The Heller Rocket, already under development, appeared to have similar military characteristics.

c. The second design employs either a conventional recoilless weapon or one which employs a venturi in the cartridge case. It would weigh 21 pounds and would fire a rocket assisted projectile at an initial velocity of 300 f/s. The rocket assist would increase the velocity to 900 - 1200 f/s. The accuracy of this weapon would be influenced by action of the rocket assist on the yawing of the rocket. The rocket assist would tend to accentuate the yawing effect. The variable velocity would hamper accurate laying on moving targets. The estimated time for development of a pilot model is 3 years.

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d. The third design would be a 90mm recoilless rifle weighing 45 pounds and incorporating a venturi in the cartridge case. It would fire a conventional high rotation HEAT shell at an M.V. of 1200 f/s. The estimated armor penetration is 6.4 inches at 90°, employing composition B and a copper cone. If the fluted charge is successfully developed, this may be increased to about 9.3 inches. The estimated time for development of a pilot model is 4 years.

6. The 81mm Recoilless Mortar is now under development. It employs a standard mortar barrel plus a reaction chamber. It will fire an 8 pound fin stabilized projectile at an estimated velocity of 900 f/s. The expected armor penetration of this shell is 10 inches. The accuracy should be comparablt to that of the Heller rockets.

7. The 81mm Gun, T107 will employ the low-sustained pressure principles. It will fire a 10-pound HEAT Shell at 2400 f/s. The weight of the gun and mount is 1200 pounds. This is a closed breech type of gun, firing a fin stabilized projectile.

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DISCUSSION AND RECOMMENDATIONS:

1. At a conference held at Army Field Forces Board Number 3 at Fort Benning, Georgia on December 8-9, 1948 to make recommendations for the development program of recoilless weapons and ammunition, a list of recommendations was determined and agreed to by the majority of members attending this conference.

This conference was attended by representatives from AFF Headquarters, The Directorate of Board 3, representatives from the Office, Chief of Ordnance, The Infantry School, The Canadian Government, The Armored Force School, Board No. 1 and the 82nd Airborne Division.

The recommendations made at the above conference were based on statements of representatives of the Office, Chief of Ordnance that the copper cone and Comp B loading would increase the armor penetration of the HEAT Shell two to two and one half times the present penetration. The resultant increase (in armor penetration) of the 75mm HEAT Shell would therefore practically equal the armor penetration requirement set up by the Antitank Defense Conference held at Fort Monroe, Virginia in October 1948.

In a letter to Colonel O. S. Rolfe, dated 17 December 1948, (see Appendix B) Mr. G. M. Taliaferro qualified this statement to the effect that this is obtained in static firing and that in actual plate firing the increase in penetration for spin stabilized shell is in the nature of 25% with possible increase if better Comp B loading technique is developed.

Since the above information changed the basis for the recommendations arrived at by the conference on December 8-9, 1948, another conference was held at Army Field Forces Board Number 3 on December 21, 1948, at which only the Directorate of Board No. 3 and representatives of The Infantry School were present. The new information was considered, and as a result a new set of recommendations was prepared and agreed to by the majority of those attending. Some of these recommendations were not agreed to by a minority of the conferees. The minority report is included as Appendix A.

2. The following facts have been determined as results of the conference held on December 8-9, 1948, at Fort Benning, Georgia and information contained in letter from Mr. Taliaferro to Colonel Rolfe dated 13 December 1948. Also see chart attached hereto and marked Appendix C.

a. The Ordnance Department representatives at the conference held on December 8-9, 1948 stated they do not have in mind any weapon which will meet the requirements set up by the Antitank Defense Conference at Fort Monroe, Virginia, for a man-portable recoilless weapon which will have an effective range of 2500 yards against frontal armor, of any potential enemy tank with 75% first round accuracy, assuming not more than 5% range determination error under optimum conditions.

b. Recoilless weapons of 75mm, or smaller, in caliber will not, even with the best known designed weapon and ammunition, be able to meet the armor penetration required by the Antitank Defense Conference.

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c. The smallest caliber weapon (other than Rockets, which have neither desired range nor accuracy) which is capable of firing a projectile with the required armor penetration characteristics is the 105mm gun. With present know how, the only projectile which can be fired from this gun and which will achieve the desired armor penetration will be the fin stabilized HEAT shell.

d. It cannot be expected that the 105mm recoilless gun can be broken down into man-portable weights. The minimum weight that can be anticipated for the 105mm recoilless gun will probably be between 250 and 300 pounds.

e. It is to be expected that a fin stabilized projectile weighing approximately 20 pounds can be developed for use in the 105mm recoilless gun weighing between 250 and 300 pounds which will have the armor penetration characteristics set up by the Antitank Defense Conference at Fort Monroe, Virginia.

f. The probable error of a 20 pound fin stabilized projectile fired from a 105mm recoilless gun weighing between 250 and 300 pounds should not exceed one mil at ranges up to 2500 yards. This is based on an accurate range determination. Errors will increase as range determination error increases.

3. While the ultimate goal for an anti-tank defense weapon which, it is assumed will be used at the battalion level, is one which will meet the requirements as set up by the Anti-Tank Defense Conference, it is obvious from the facts brought out by the conference held at Fort Benning, Georgia, on December 8-9, 1948, that it will be several years before such a weapon may be expected. It is the consensus of the personnel attending this conference that the most urgent requirement which exists at the present time is for a weapon and ammunition which is capable of destroying the best known enemy armor. The facts brought out at this conference show that we do have the weapon and ammunition which have the required armor penetration characteristics. However, this gun will not meet the requirement for a man-portable recoilless weapon. The Ordnance representatives have stated that we could possibly expect a gun and ammunition to meet the armor penetration characteristics within a year and a half. It now becomes a question of whether it is more desirable to accept a gun which does not meet the weight characteristics but which will give the desired armor penetration characteristics, or to wait several years for the development of a weapon which will meet both the weight and armor penetration characteristics. It was the opinion of the majority of the members of the conference that it is more desirable to accept the gun and ammunition which will not meet the required weight requirements but which will meet the armor penetration requirement. It is further to be brought out that while the gun will not meet the weight requirement it is possible that this gun may be broken down into components, each of which may be carried by two or three men for short distances.

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4. Based on the above facts the following recommendations are submitted:

a. That a breakdown type lightweight 105mm recoilless gun weighing not more than 285 pounds and suitable ammunition therefor (to include the HEAT shell mentioned in b below) be developed in accordance with detailed military characteristics to be submitted by AFF Board No. 3 with a priority of 1B.

b. That a fin stabilized HEAT projectile weighing approximately 20 pounds and having a muzzle velocity of approximately 1020 f/s be developed for the new lightweight 105mm recoilless gun in accordance with detailed military characteristics to be submitted by AFF Board No. 3 with a Priority of 1B.

c. That the current development of the Rocket, 2.36 inch, T59 series, be continued with Priority 1B.

d. That a project be initiated to improve the penetration on sloping armor, the accuracy and temperature range of the 3.5 inch rocket (M28) with a priority of 1B.

e. That interest be expressed to the Canadian government in the early development of the Heller Rocket and that AFF be kept informed of the progress of such development.

f. That fin stabilized HEAT shells suitable for use in the 90mm Tank gun and the 75mm Recoilless Rifle, M20, be developed with a priority of 1C, military characteristics for the latter shell to be submitted by AFF Board No. 3.

g. That the development of the new HE and Smoke Shells for the 75mm Recoilless Rifle, M20, be continued with present priority.

h. That the Cartridge, HEAT, 57mm, M307, and the Cartridge, HEAT, 75mm, M310, be modified to incorporate currently available improvements to increase armor penetration and be sent to AFF Board No. 3 for check test. That a 1C priority be assigned this project.

i. That the development of the 75mm Recoilless Rifle (breakdown type) T21E10, be continued with present priority.

j. That development of a lightweight 75mm Recoilless Rifle be postponed pending completion of development of the 57mm and 105mm lightweight recoilless weapons.

k. That the development of the lightweight 57mm Recoilless Rifle with suitable ammunition be continued with present priority.

l. That all HEAT projectiles to be developed for recoilless weapons be provided with 2500 yard tracer elements.

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m. That the requirement by The Infantry Conference for a multi-purpose weapon has not been met by the Little Report. However, the third proposal of that report does warrant further development and development of a weapon and ammunition in accordance with this proposal is recommended with present priority. That upon completion of preliminary design studies of this weapon and its ammunition, that a conference be held with this Board for the purpose of reviewing the project.

n. That the development of the improved rifle grenade be continued.

o. That sights for future 57mm recoilless rifles be provided for direct fire only.

p. That sights for 75mm and larger caliber recoilless weapons be provided for use in both direct and indirect fire.

q. That no further consideration be given to the development of a 16 pound rocket and launcher therefor.

r. That the development of the recoilless antitank weapon recommended in paragraph 6h(6) of the Antitank Defense Conference be accelerated.

s. That the above recommendations in no way alter the requirements of the Fort Monroe, Virginia, Antitank Defense Conference, 6-8 October 1948, but are made to provide the best known interim items.

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5 January 1949

The undersigned conferees do not concur with that part of the recommended program which deemphasizes the development of the lightweight 75mm Rifle and its ammunition, and which substitutes the development of a lightweight 105mm Rifle and its ammunition.

Our reasons are as follows:

a. The proposed lightweight 105mm Rifle will not be a satisfactory substitute for the 75mm Rifle as a close support weapon, due to weight.

b. The situation with respect to armor penetration of the 75mm HEAT round (as indicated in Mr. Taliaferro's letter of 13 December 48) is no more unfavorable than it was on 7 October 1948 when the present antitank program was adopted.

c. The deficiency of the 75mm HEAT round in armor penetrating ability demands acceleration of the anti-tank program - specifically the early development of the recoilless AT Weapon for which performance characteristics are defined in Par. 6 n (6) of the Report of Conference on Antitank Defense, 6-7 October 1948.

d. The interjection, at this time, of a requirement for another interim weapon in the same field - a weapon with admittedly inferior characteristics - can only result in confusion, and dispersion of effort.

e. The statement of an Ordnance representative, that "Ordnance has no weapon in mind" (to meet the requirements for a man-portable recoilless weapon) is understood by us to indicate the extent of one man's knowledge of the situation. It is in no sense an official admission that the requirement of the Antitank Defense Conference will not be met.

We therefore submit the following exceptions to the recommendations adopted by the majority of the conference on 21 December 1948:

Recommendation 4 a - Do not concur.

Recommendation 4 b - Do not concur.

Recommendation 4 f - Change the words "Priority 1C" to read "Priority 1B".

Recommendation 4 j - Do not concur. Substitute the following "That a recoilless 75mm Rifle, weighing not over 75 lbs., and suitable ammunition therefor be developed with a Priority of 1B".

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We concur with all recommendations other than those listed above.

Douglas Sugg

DOUGLAS SUGG, Col, Inf.
Chief, Tac. Sec., TIS

Burton L. Lucas

BURTON L. LUCAS, Col, Inf.
President, AFF Bd. No. 3

Paul Cooper

PAUL COOPER, Col, Inf.
Tac. Sec., TIS

Charles W. Pence

CHARLES W. PENCE, Col, Inf.
Inf. Director, AFF Bd. No. 3

Richard K. Boyd

RICHARD K. BOYD, Lt. Col., Inf.
Abn. Director, AFF Bd. No. 3

William B. Moore

WILLIAM B. MOORE, Lt. Col., Inf.
Secretary, AFF Bd. No. 3

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APPENDIX A

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GNTaliaferro/pd/74961

ORDTM

13 December 1948

Colonel O. S. Rolfe
Headquarters, Army Field Forces
Fort Monroe, Virginia

My dear Colonel Rolfe:

During the conference last week I made the statement that the copper cone and Comp B. loading approximately doubled the penetration of the HEAT shell. I would like to qualify the statement to the effect that this is obtained in static firing and that in actual plate firing the increase in penetration for spin stabilized shell is in the nature of 25% with possible increase if better Comp B. loading technique is developed.

I would appreciate it if the notes of the meeting would be amplified to incorporate the above. We will still incorporate all possible improvements in any HEAT shell under development. At the present time there is no anticipated manufacture of standard HEAT ammunition.

Respectfully,

/s/ G. N. Taliaferro
/t/ G. N. TALIAFERRO

CC: Col. Rosebaum

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APPENDIX B

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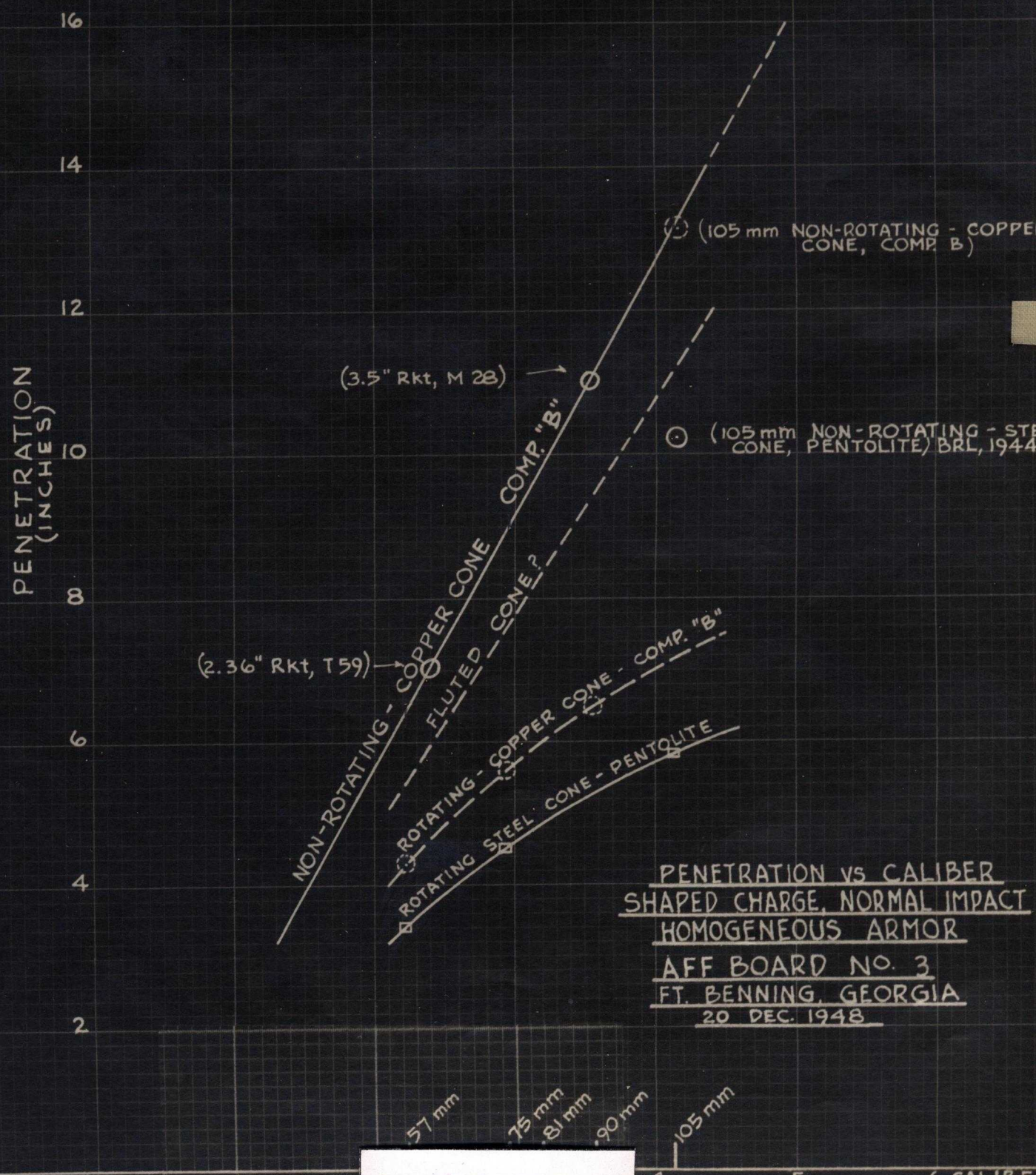

PENETRATION vs CALIBER
SHAPED CHARGE, NORMAL IMPACT
HOMOGENEOUS ARMOR
AFF BOARD NO. 3
FT. BENNING, GEORGIA
20 DEC. 1948

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ARMY FIELD FORCES BOARD NO. 3
Fort Benning, Georgia

PROPOSED PROGRAM OF CONFERENCE ON RECOILLESS WEAPONS

1. Opening Remarks - Colonel Lucas.

2. Review of requirements by Stillwell Board and Infantry Conference.

Review of pertinent recommendations by the Antitank Defense Conference - Colonel Rosebaum.

3. Review of the tactical doctrine for the employment of man-portable recoilless weapons - Lt Colonel Harris and Major Brownfield.

4. Review of present Army Field Forces recoilless weapons and rockets - Lt Colonel Stuart.

5. Multi-Purpose Weapon, Lightweight Recoilless Rifles, 57mm and 75mm and 105mm Recoilless Rifle Development - Dr. Hedge.

6. Fin Stabilized HEAT Shell, Ammunition for Multi-Purpose Weapons and ammunition for other new development items - Mr. Taliaferro.

7. Rocket Developments - Mr. Hopkins.

8. Discussion of capabilities of weapons and ammunition to be developed to meet present requirements - Members of Conference.

9. Formulation of Programs for Presentation to Conference Members by selected personnel - Special Committee.

10. Study of Formulated Programs by Conference Members.

11. Discussion of Formulated Programs by Conference Members.

12. Redraft and final submission of Programs - Special Committee.

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The purpose of this conference is to arrive at recommendations for a development program for recoilless rifle weapons.

In June of this year this Board received a directive from AFF to make a study, in coordination with The Infantry School, to determine the requirement for a 75mm Recoilless Rifle weighing 75 pounds or less and for a 57mm Recoilless Rifle weighing 25 pounds or less and the desired military characteristics for these.

In the meantime the Antitank Defense Conference held at Fort Monroe, Virginia, has set up a requirement for a recoilless weapon with certain characteristics. The Ordnance Department has been carrying on studies on new recoilless type weapons and ammunition. Some of these show great promise. However, none of these items has been proven and it is understood that few have even reached the design stage. It would therefore appear that, with the development money and personnel available, it may be six to eight years before these weapons and ammunition are available. In the meantime, there is in the design stage, in the case of the 75mm Recoilless Rifle and in the manufacture stage, in the case of the 57mm Recoilless Rifles, lighter weight weapons with capabilities equal to, but not greater than our present weapons. It is expected that these weapons, in addition to being lighter, will also have improved safety features. It is also understood that these weapons will necessitate development of new type ammunition, since the present standard ammunition will not fit these weapons. Neither of these weapons meet our present requirements.

This conference proposes to review the requirements for recoilless rifles and to review the development program and then arrive at recommendations for the development program. It appears that the time element required in the development of these various possible new weapons is the main factor in arriving at these recommendations.

You have been given a copy of the program for this conference. It is requested that any questions which you may have on the prepared presentations be held until the person presenting his data has finished. You will note a period has been set aside for a round table discussion upon completion of all prepared presentations. We shall now begin with a review of the requirements for recoilless rifles as set forth in the W. D. Equipment Board Report, the Infantry Conference, and the Anti-Tank Defense Conference.

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ARMY FIELD FORCES BOARD NO. 3
Fort Benning, Georgia

6 December 1948

SUMMARY OF W. D. EQUIPMENT BOARD REPORT

Recoilless gun are valuable Infantry weapons and the 57mm, 75mm and 105mm recoilless guns should be further developed. (Par 15, Sec II).

Development (of recoilless guns) should be continued to produce weapons with improved accuracy, range, reliability, decreased blast effect and lighter weight of weapon and ammunition. (Par 1, Sec XV).

Since Infantry weapons must be man-portable for considerable distances, they must combine maximum effectiveness with minimum weight. Recoilless guns are required which can be easily man-packed either in one piece or disassembled into convenient loads. Provisions should be made for mounting Infantry recoilless weapons on any Infantry vehicle. (Par 3, Sec XV).

Types and calibers:

a. 57mm Rifle: The present 57mm rifle is too heavy. Development and redesigning should continue to reduce the weight, improve the reliability of mechanical functioning, decrease the time of flight of the projectile, improve the accuracy, and relocate sights and operating mechanisms for the comfort of the operator.

b. 75mm Rifle: The present 75mm recoilless rifle should be improved to make it lighter, more accurate, and more reliable. The time of flight should be reduced. The gun, accessories and mount should be capable of quick, easy breakdown into man packed loads, and sights and operating mechanism relocated for the comfort of the operator.

c. 105mm Rifle: The 105mm recoilless rifle should be made lighter and should be capable of quick, easy breakdown into man-packed loads.

Ammunition: In addition to general improvements in effectiveness, safety, reliability, and accuracy of ammunition for recoilless weapons, the following objectives should be sought in whatever developments are undertaken:

a. Reduction of breech blast effect, flash and smoke.

b. Reduction of weight and volume of propelling charge.

c. Increase in muzzle velocity and armor penetration.

d. Improvement of waterproofing of propellant.

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Accessories:

a. Mounts: The weight should be kept to a minimum by careful engineering and the use of light alloys. Multiple gun mounts, with automatic loading features, should be developed for use on self-propelled carriages.

b. Sights. Suitable sights for both direct and indirect fire should be provided for recoilless weapons.

SUMMARY OF INFANTRY CONFERENCE (T-4)

The need in the Infantry is for an easily transportable, accurate weapon capable of keeping up with the assault echelons and powerful enough to stop armor, reduce pillboxes, and provide close fire support in both attack and defanse. These features are possessed to some degree by the recoilless weapons, as well as by rocket projectiles of the bazooka type, both with various limitations and disadvantages. The conference feels that the greater range and accuracy of the recoilless weapons over the rocket, in their present form, requires the retention of recoilless weapons, at least for the present, in the Infantry requirement.

Recommendations:

1. That the Infantry Regiment retain the present recoilless weapons of 57mm and 75mm caliber.

2. That further consideration be given the 105mm Recoilless Rifle as an Infantry weapon.

3. a. That the 57mm Recoilless Rifle be retained in its present place in T/O and E of the Infantry Regiment.

b. That the 75mm recoilless platoon remain in the heavy weapons company.

c. That the transportation of the 75mm platoon be changed from $1\frac{1}{2}$ ton vehicles to $\frac{1}{4}$ ton vehicles.

4. That research and development of recoilless weapons and ammunition be continued to improve range, decrease weight, increase penetrating power and reduce flash back.

5. That simultaneously development be initiated of a weapon and ammunition designed to replace the 2.36" and 3.5" rocket launchers and the 57mm Recoilless Rifles. This weapon to have flat trajectory, the accuracy of the recoilless rifle at ranges up to 1000 yards and the ability to penetrate any known armored vehicle. The weight of the weapon and ammunition not to exceed, and preferably to be less than, that of the present 3.5" launcher and rocket.

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RECOMMENDATIONS OF ANTITANK DEFENSE CONFERENCE

The Antitank Defense Conference held at Fort Monroe, Virginia, on October 6-7, 1948 recommended requirements for the following:

a. Man-portable Rocket Weapons - -

Providing effective antitank fires against tanks of any class at 500 yards, with first round accuracy of 75%.

b. Man-portable (or handled) recoilless rifle weapons -- Providing effective antitank fires against tanks of any class at 2500 yards, with first round accuracy of 75%, allowing 5% (or less) range determination error.

c. Rifle grenades -- Providing effective antitank fires against medium tanks at 50 yards.

DIRECTIVE FOR STUDY OF LIGHTWEIGHT RECOILLESS RIFLES

Army Field Forces directed Board 3, in coordination with The Infantry School, to make a study to determine:

a. Army Field Forces requirement for a 75mm Recoilless Rifle, weighing 75 pounds or less and the desired military characteristics therefor.

b. Army Field Forces requirement for a 57mm Recoilless Rifle, weighing 25 pounds or less and the desired military characteristics therefor.

A letter from the Office, Chief of Ordnance stated that studies indicated that the 75 pound, 75mm Recoilless Rifle is practicable and that a 25 pound, 57mm can be made.

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TACTICAL EMPLOYMENT OF THE 75MM RIFLE

The mission of the 75mm rifle platoon is to support the battalion, or elements of the battalion, by engaging targets of opportunity with direct fire. Appropriate targets for the 75mm rifle are: automatic weapons, antitank weapons, grouped personnel, pillbox embrasures, and vehicles of all types including armored vehicles.

In the defense, armored vehicles are the primary targets for the 75mm rifle. In the attack, crew served weapons which are holding up the advance are of primary importance. However, they may be given a specific mission of engaging other types of targets.

The 75mm rifles are employed generally to support the forward elements of the battalion by direct fire. Indirect fire methods are employed only when supporting mortar or artillery fires are not available.

The 75mm rifles, in the defense, are sited to cover tank approaches into the battalion area and in front line battalions are located to engage hostile armor forward of the main line of resistance. When tanks are employed in the battalion defense area, the 75mm rifles are used to supplement the antitank fires of the tanks. The flat trajectory of the weapon will require, in most terrain, that they be located in the forward platoon areas to permit a complete coverage of the close-in portions of tank approaches into the area.

The 75mm rifles within a section are sufficiently separated to prevent a hostile tank from engaging more than one at a time, but are normally sited so that both 75mm rifles are mutually supporting, i.e., the two guns of the section are sited to cover the same approach. Although it is undesirable the situation may require that the two weapons of the section be employed separately in order to cover all approaches into the battalion area. Due to the limited armor penetrating ability of the 75mm rifle they are sited to deliver flanking fire against the sides of tanks insofar as possible.

The fires of the 75mm rifles are coordinated with the fires of other antitank weapons in such a manner that they, in conjunction with antitank mine fields and other tank obstacles, provide the most effective antitank defense of the area.

The 75mm rifles are employed in the attack to support the assault echelons by direct fire. The situation and the terrain will usually dictate that the sections be employed in direct support of assault companies. However, in order to facilitate control and to gain some mass fire effect, the platoon will be employed in general support whenever possible.

In selecting position areas for the 75mm rifle platoon an important factor to be considered is the distance the platoon must move from off carrier position to occupy the firing position. These position areas fall into three general locations:

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Positions may be selected in the vicinity of the forward rifle elements. However, the difficulties of ammunition supply may limit their supporting capabilities.

Positions may be selected on the flank of the supported unit. Such positions often afford better fields of fire and more effective cover. These positions, however, present the same difficulties in ammunition supply.

Initially, the platoon may man all of its weapons, 2 per section, but the weight of the gun and ammunition limit the capabilities of the section to 1 gun and ammunition (6 rounds) in the movement to subsequent positions.

In an attack of a fortified position the 75mm rifles deliver fire on embrasures or other openings in pillboxes, bunkers etc. They can usually occupy positions much closer to the fortification than tanks or towed weapons.

In order to obtain close direct fire support on the far bank during a river crossing the 75mm rifle platoon crosses the river with the leading elements. They provide antitank defense of the bridgehead and assist in its enlargement by destroying weapons emplacements, pillboxes, bunkers etc.

In airborne operation the 75mm rifles may be dropped with the initial drop in order to provide antitank protection of the drop-zone. This method may require a long hand carry in order to occupy suitable firing positions. If the situation will permit the early landing of gliders the antitank defense of the drop-zone may be established more quickly in sufficient strength by landing the platoon with crew, weapons, ammunition, and light vehicles by gliders.

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TACTICAL EMPLOYMENT OF THE 57MM RIFLE

The 57mm rifles organic to the weapons platoon of the rifle company are employed generally to provide close fire support to the company or its elements. They engage by direct fire definitely located targets which appear within their assigned sector. Suitable targets for the 57mm rifle are pill-boxes or similar fortifications, automatic weapons emplacements, groups of personnel and vehicles including armored vehicles.

In the attack, the 57mm rifle squads are normally attached to each of the three rifle platoons. The squad is displaced as necessary to maintain close support of the supported platoon. When an objective is captured the squad is displaced promptly to positions from which it can protect the reorganization of the supported unit.

When the terrain and situation permit, two or more squads may be employed under the direct control of the section leader in order to facilitate a more rapid destruction of targets.

In exceptional circumstances, the 57mm section may be assigned the primary mission of providing antitank protection for the company.

In the defense the 57mm rifle section is normally employed under company control with one squad located in each of the rifle platoon areas. The 57mm rifles reinforce the fires of the rifle platoons by engaging with direct fire groups of personnel, crew served weapons, or armed vehicles which threaten the area.

In situations requiring special transportation such as amphibious operations, river crossings or airborne operations the 57mm squads are attached to the rifle platoons. Once the beach, far bank or drop-zone is gained the weapon is employed in the same manner as in other types of operations.

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ARMY FIELD FORCES BOARD NO. 3
Fort Benning, Georgia

6 December 1948

RECOILLESS WEAPONS TO MEET TACTICAL REQUIREMENTS

Gentlemen: You have heard the principles of tactical employment of our present recoilless weapons as presented by Lt. Colonel Harris, Tactical Section, The Infantry School.

It is appropriate at this time to review the mission for "man-portable antitank weapons as stated by the Antitank Defense Conference at Fort Monroe, 7-8 October 1948, and to examine the characteristics of our present weapons in the light of that mission. The conference established the following: "The effective range is to be not less than 2500 yards against frontal armor of any potential enemy tank, with 75% first round accuracy, assuming not more than 5% range determination error under optimum conditions. Every attempt should be made to maintain these weapons at man-portable weighs and to provide satisfactory portable range finders".

Our present recoilless weapons were not designed specifically as anti-tank weapons, but rather as weapons to deliver direct fire on point targets which could not effectively be engaged by other type weapons then in existence.

With the above mission in mind, let us examine the 57mm and 75mm rifles. The essential characteristics of each weapon and its ammunition are listed in Appendix 1 & 2.

Beginning with the 57mm Rifle, M-18, we find the following disadvantages which either effect its present employment, or do not meet the requirements above:

1. Weight. The present weight is excessive. We have established an ideal load of 25 pounds per man.

2. Mounts. The present bipod is satisfactory except for tracking in the prone position. The auxiliary mount, the M1917A1 tripod is unsatisfactory because of its weight (53.2 pounds) and high silhouette. The other mounts listed are not standard, but expedients only.

3. Ammunition:

H.E.: the present round has performed satisfactorily except on graze impact at low angles.

HEAT: the present round lacks sufficient penetration.

W.P.: the present round has performed satisfactorily.

T.P.: this round is satisfactory.

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Accuracy: The present ammunition does not meet the accuracy requirement of 75% hits at 2500 yards. Rounds vary within the same lot, and between lot numbers.

Loading: The present rate of loading is slow due to the necessity of meshing the rotating band with the lands and grooves of the tube.

Waterproofing: The present round is not waterproof except when in the sealed metal container. This increases the weight to be carried from 5.3 pounds to 7.12 pounds per round.

Sights: The present telescopic sight does not meet the range requirement of 2500 yards, being graduated only to 1900 yards. The auxiliary metal sights are graduated only to 1100 yards.

Backblast; flash, smoke, and safety to personnel:

The backblast area imposes the disadvantage of kicking up dust, thus revealing the gun position. This may be reduced by the intelligent selection of gun positions. However, the flash draws attention to the position, while the smoke enables an observer to fix that position.

Personnel must be thoroughly trained in safety precautions to be observed during firing or accidents will result. Modifications to the weapon and in the training procedure have been recommended to increase the safety of personnel.

In summary it is apparent that the 57mm Rifle, M-18, does not meet the requirements for frontal armor penetration, nor accuracy, and is not provided with sighting equipment to perform the mission. The present weapon is classified as a close-in antitank weapon by A.F.F. and due to its lack of penetration must be employed to deliver flanking fire. It is more accurate than the 2.36 or 3.5 inch rocket launchers and has a greater maximum usable range. It lacks the penetration of the 2.36 inch rocket launcher mainly because the projectile is spin stabilized.

Let us now consider the 75mm Rifle, M-20. The following facts are noted:

1. Weight: The weight of the rifle is excessive, requiring four men to carry the rifle alone. The present weapon cannot be broken down into separate loads.

2. Mounts: The M1917A1 tripod, currently standard, is too heavy, weighing 53.2 pounds. The elevating and traversing mechanisms were not designed to operate under a load of 115 pounds, and do not at all times operate satisfactorily.

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The experimental tripod, T-113, weighing 25 pounds is unsatisfactory in three respects: (1) The elevating mechanism is located in an awkward place for manipulation by the gunner; (2) has the same disadvantage as that mentioned above for the M1917A1 mechanism; (3) the elevating pin is difficult to remove and replace.

3. Ammunition:

(1) Shell, HE, M-309. This shell has proved satisfactory.

(2) Shell, HEAT, M-310. This round does not give sufficient armor penetration.

(3) Shell, Smoke, WP, M-311. This round has been satisfactory with exceptions in functioning of the booster.

(4) Shell, T.P. (M-309). This round has been satisfactory.

(5) Weight of all rounds: The weight of each type of round varies slightly from the others; however, all are too heavy.

(6) Accuracy: It is apparent from the probable error obtained from the firing table, that the present ammunition does not meet the accuracy requirement.

4. Sights: The direct fire sight, telescope, M85C is graduated for range from zero to 2100 yards, and for deflection or leads from zero to 30 mils, or sufficient leads to engage a target moving from zero to 20 miles per hour with present ammunition. This sight has been satisfactory. The sight mount adjusting worms, however, have not been entirely satisfactory in boresighting. This sight obviously does not meet the requirement for range.

5. Rate of Fire: The present maximum rate of nine (9) aimed rounds per minute depends upon the ability of the crew to service the piece. Again this operation is slowed by the requirement of matching the pre-engraved rotating band with the lands and grooves of the tube. A sustained rate of fire has been set at two (2) rounds per minute to lengthen or preserve the life of the breech mechanism. This rate would be disregarded in an emergency provided the situation warranted the expenditure of the gun. The erosion in the breech mechanism has been too great, reducing the life of the chamber and vent bushing to under 450 rounds. (This figure is based on limited test and is not firm). Wear on the tube is negligible. Replacement of the vent bushing must be performed by Ordnance personnel.

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6. Backblast, flash, smoke, and safety of personnel.

Here also, the backblast kicks up dust revealing the gun position. Also, the flash draws attention to the position and the smoke fixes the location of the position. These factors may be reduced by selection of position.

The backblast also imposes a problem in training as for the 57mm Rifle.

Summarizing the discussion on the 75mm Rifle, M-20, we find that the rifle does not meet the requirements as follows:

1. The rifle is considered as a close-in antitank weapon by A. F. F.

2. The rifle and ammunition do not meet the accuracy requirements for 75% first round hits at 2500 yards.

3. The HEAT round will not penetrate the required frontal armor plate.

4. The present direct fire telescope is graduated only to include 2100 yards.

Recommendations

A. 57mm Rifle

(1) That the weight of the rifle be reduced to 25 pounds. The rifle should be of such size as to permit packaging in standard containers for airborne operations, or to be carried by parachute personnel in a leg pack.

(2) Present range of the rifle is satisfactory. Accuracy should be improved without increase in the weight of the rifle or ammunition.

(3) That the bipod be improved to permit easier tracking when firing the rifle from the prone position.

(4) That if any tripod is required for the 57mm rifle, that the T-113 tripod be substituted for the M1917A1 tripod.

(5) That the penetration of the HEAT round be increased to meet the requirement prescribed by the A/T/Def. Conf. This increase in penetration to be gained without loss of accuracy nor increase in weight of the rifle.

(6) That a loading detent be provided on the ammunition to increase the rate of loading; waterproofing of the propellant retainer to eliminate the use of the metal container; reduction in weight of the shell case; development should be continued to eliminate the variation between rounds and differences in lot numbers.

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(7) Accuracy of the rifle and ammunition be improved to meet the requirement of 75% first round hits at 2500 yards.

(8) Provide a telescope graduated for direct fire, combining range and leads, with a maximum range of 3000 yards, and with sufficient leads to engage a moving target travelling at a speed of 30 miles per hour.

(9) Provide an auxiliary sight to be used when the telescope becomes lost or damaged, meeting the same requirements.

(10) Elimination of smoke and flash.

B. 75mm Rifle.

(1) Weight of the rifle be reduced to 75 pounds or less. The rifle to be capable of breakdown to permit ease of handling, and packaging for airborne operations, keeping in mind the ideal weight of 25 pounds per man for cross country movement.

(2) Mounts: a. Provide an integral mount, similar to the bipod on the 57mm rifle, with an elevation adjustment of not less than -50 to plus 200 mils, capable of being rapidly shifted for deflection while in place. Weight not to exceed 25 pounds, and preferably to weigh not over 10 pounds. This mount to be considered as an assault mount for direct fire only. The mount should be capable of being folded so that the weapon can be carried with the mount attached and not interfere with movement.

b. A second mount be provided, weight 25 pounds or less, capable of elevation for the maximum range of the rifle. The elevating and traversing mechanisms to be simple but efficient. No means of cross leveling is necessary. That the tripod legs of the mount be detachable, so as to permit mounting of the rifle on the dash mount of a 1/4 ton truck.

(3) Ammunition:

a. Penetration of the HEAT round be increased to meet the requirement of penetrating the frontal armor of any known tank. Increase in penetration to be gained without loss of present accuracy nor increase in weight of the weapon.

b. Accuracy of the rifle and ammunition be improved to meet the requirement of 75% first round hits at a range of 2500 yards, with an allowable error of 5% range estimation error under optimum conditions.

c. Reduction in the weight of the ammunition. Again the ideal weight load of 25 pounds is desirable. Emphasis should be directed toward a reduction in the weight of the shell casing and increase in fragmentation.

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d. Provide a rapid means of loading ammunition, without the requirement of meshing the rotating band and lands and grooves.

e. Provide a waterproof propellent retainer. This will eliminate the requirement for a metal sealed container.

f. Eliminate variables among rounds and between lot numbers.

(4) Sights. a. Provide a direct fire telescope combining range and deflection, with a maximum range graduation of 3300 yards (300 mils) and sufficient leads to engage a moving target travelling at a speed of 30 miles per hour. The present indirect fire sight is entirely satisfactory. However, it is recommended that a more efficient adjusting mechanism be provided on the sight mount.

(5) Eliminate smoke and flash.

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APPENDIX I

CHARACTERISTICS, 57MM AND 75MM RIFLES

1. 57MM RIFLE, M-18

Weight, (with sight & integral mount): 44.4 pounds

Length: 62.0 inches

Mounts: Shoulder, bipod, or M1917A1 tripod, 53.2 pounds

May also be fired from light tripod, dash or pedestal mount of 1/4 ton truck.

Carry: with integral mount, short distances, One Man

Ammunition: Types currently available; HE, HEAT, WP, TP.

Weight, complete round, 5.3 pounds

Projectile, 2.75 pounds

Weight, complete round in metal container 7.12 pounds

Muzzle Velocity, all rounds, 1200 fps.

Maximum range, all rounds 4340 yards

Accuracy:

Range Probable Error, 600 yards,	6 yards
Deflection Probable Error, 600 yards,	0 yards
Range Probable Error, 2500 yards,	14 yards
Deflection Probable Error, 2500 yards,	2 yards

Penetration, HEAT round (spin stabilized)--up to 3.2 inches at 30° obliquity $3\frac{1}{2}$" at 0° obliquity.

SIGHTS:

Telescope Sight, M86C, for direct fire, graduated from zero to 1900 yar

Metal Sights, (Auxiliary) graduated from zero to 1100 yards.

Backblast Area: The danger zone is triangular in shape. It extends approximately 50 feet to the rear of the point of emplacement and at its widest point covers a space 20 feet on either side of the axis of the emplaced rifle. Personnel should not face the rifle when within 100 feet of the rear of its breech because of the danger of flying objects which might be picked up and thrown to the rear by the blast action.

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2. 75MM RIFLE, M-20.

Weight of rifle and sights, (less mount) 114.5 pounds

Mounts: Standard --- M1917A1 tripod 53.2 pounds

(Rifle may also be mounted on light machine gun tripod, dash or pedestal mount of jeep).

T-111 tripod, (experimental) 25.0 pounds

Carry: Crew consists of 10 men with loads as follows:

Section Leader -- sights and other fire control equipment
Gunner -- M1917A1 tripod
Four men (4) -- Carry the rifle
Three men (3) -- Ammunition bearers, two (2) rds. each
Total -- six (6) rounds

Ammunition: Types, HE, HEAT, WP and TP.

Weight complete round, approximately	22 pounds
Weight of projectile, approximately	14 pounds
Weight of complete round in metal container	27 pounds
Muzzle velocity, HE, WP, and TP	990 fps
HEAT	1000 fps
Maximum range, HE and TP	6955 yards
WP	7020 yards
HEAT	7200 yards

Accuracy:	600 yards	2500 yards
Range Probable Error	5 yards	20 yards
Deflection Probable Error	0 yards	2 yards

Penetration: HEAT, up to 3.7 inches at 30° obliquity (4.5 at 0°)

Sights: Direct fire telescope, M85C, graduated from zero to 2100 yards combines lead and range, maximum deflection of 30 mils (6 leads) or sufficient to engage moving targets with present ammunition up to 20 miles per hour.

Indirect fire sight, M-34, graduated beyond maximum range, with deflection of 6400 mils.

Backblast area: The danger zone is triangular in shape. It extends approximately 75 feet to the rear of the point of emplacement, and covers a space of 25 feet on either side of the axis of the emplaced rifle at its widest point. No personnel should face the weapon within 125 feet of the rear of its breech because of the danger of flying particles which might be thrown up by the blast action.

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GENERAL: The following is a survey of the present standard and development types of rockets, recoilless weapons and ammunition therefor.

1. 57mm Recoilless Weapons and Ammunition

a. Rifle, 57mm, M18 (Standard Item).

(1) Characteristics:

(a) Weight - 44 pounds. Muzzle velocity - 1200 f/s. Sights - direct fire only. Mounts - integral mount or machine gun tripod.

(2) Status: This item is standard; however, important modifications to this weapon have recently been recommended by AFF Board No. 3 for the purpose of improving safety during firing.

b. Ammunition for the Rifle, 57mm, M18.

(1) Cartridge, HE, 57mm, M306, with Point Detonating Fuse, M89. The projectile in this round is a thin walled, high capacity shell designed for use with a low powder pressure. Characteristics follow:

(a) Weight of Projectile - 2.75 pounds. Filler - .6 pounds of TNT. Range - 4,340 yards.

(2) The Fuse, PD, M89, currently standard for the above round, is satisfactory except on graze impact at low angles. The Fuse, PD, T190 is now being developed to replace this fuse in the HE and WP rounds and should give better sensitivity on graze impact.

(3) Cartridge, HEAT, 57mm, M307, with Point Initiating Fuse, M90.

(a) This round employs a conventional rotating hollow charge projectile with a point initiating fuse.

(b) Ballistics of this round are essentially the same as for the HE cartridge. The penetration of homogeneous armor at a range of 30 yards obtained in recent tests at this Board are as follows:

Slope of Plate from Normal (In Degrees)	Average Measured Length of Hole (In Inches)	Average Thickness of Armor Plate Defeated (In Inches)
60	3.	1.5
50	2.7	1.7
45	3.	2.1
40	2.9	2.25
30	3.7	3.2
0	3.5	3.5

NOTE: All rounds penetrated at least 50% of the average thickness shown above.

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(4) The Fuse, Point Initiating, M90, for the above cartridge is satisfactory and gives particularly good performance on steeply sloped armor.

(5) Cartridge, Smoke, WP, 57mm, M308, with Fuse, PD, M89. The ballistics of this cartridge are similar to those of the HE round. The projectile contains .27 pounds of WP.

(6) Cartridge, TP, 57mm, M307, with PDF M89, contains a .07 pound black powder spotting charge.

(7) The Cartridge, Drill, Sub-Caliber, 57mm, T12, is currently under development for use as a combination drill round and sub-caliber training device.

c. Rifle, 57mm, Lightweight (T66).

OCM Item 30995 approved the development of a lightweight 57mm recoilless rifle and ammunition. This project was later terminated by OCM Item 31624, which recommended that future development be in a 75mm caliber, however, it is understood that a pilot model of the T66, 57mm Rifle is under construction and will weigh approximately 21 pounds, without accessories. The most significant aspect of this development, aside from weight reduction, is the shortened cartridge case which will be required, thus necessitating a changeover in ammunition. The ammunition is under development at this time. The ballistics of the T66 rifle are to be the same as for the present standard weapon. The breech is to be of the lever operated, vertical drop block type.

2. 75mm Recoilless Weapons and Ammunition.

a. The Rifle, 75mm, M20.

(1) Characteristics:

(a) Weight - 115 pounds (without the mount). Muzzel velocity - 990 f/s. Sights are provided for both direct and indirect fire. Weapon can be mounted on light and heavy caliber .30 machine gun tripods. A lightweight mount resembling the T113 machine gun tripod mount has been recently recommended for development by the Board. The Mounts, T37 and T38, and the Carriage, T39, have recently been tested by this Board and found unsuitable due to their excessive weight and complexity.

(2) The Rifle, 75mm, M20, is standard and considerable numbers are being produced.

(3) An improved version of the rifle is being developed under authority contained in OCM 28547. The Rifle, 75mm, T21E10, will have a lever operated, vertical block, a grip type trigger resembling that on the 57mm Rifle, M18, and the tube will be in two pieces, joining at the breech. No change in ammunition design is required for the T21E10.

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b. Ammunition for th[illegible]

(1) Cartridge, HE, 75mm, M309, with Point Detonating Fuse, M51A4 (super-quick - .05 seconds delay).

(a) Weight of complete round - 22 pounds. Weight of projectile - 14.4 pounds. Weight of shell filler - 1.49 pounds (TNT). Maximum range - 6,955 yards. Effective bursting area - 40 yards by 6 yards (Figure 68, TM 9-1907). Initial fragment velocity - 3,120 f/s. Number of effective fragments at 10 yards radius from the burst - 850.

(2) AFF Board No. 3 Project No. 2115 recommended the development of a new thin walled, high capacity HE shell for the 75mm Recoilless Rifle, M20. The estimated velocity for this projectile is 1,200 f/s. A weight saving of approximately 4½ pounds is expected, together with a considerable increase in fragmentation and blast effect.

(3) Fuses.

(a) The M51A4 Super-Quick Delay Fuse, now standard for the HE round, is generally satisfactory under most condition

(b) The Fuse, Mechanical, Time, Super-Quick, M500, recently standardized, is to be tested by this Board in the immediate future. It is anticipated that this fuse will be recommended for issue as a standard item in addition to the M51A4 fuse.

(4) The Cartridge, HEAT, 75mm, M310, with Base Detonating Fuse, M91, is now standard. All rounds now on hand have the BD Fuse M62A1. It is a conventional rotated HEAT shell with ballistics essentially the same as those of the HE round. Penetration of homogeneous armor at 30 yards range obtained in recent firings by this Board are as follows:

Slope of Plate From Normal (in Degrees)	Average Measured Length of Hole (in Inches)	Average Thickness of Armor Plate Defeated (in Inches)	% of Rounds Penetrating Less than ½ the Average Thickness of Plate
60	2.6	1.3	56
50	3.1	2.0	0
45	4.1	2.9	0
40	4.3	3.3	0
30	4.3	3.7	0
0	4.5	4.5	0

(5) The Shell, HEAT, 75mm, T47E4, with Point Initiating Fuse, T150E1, is currently under development. This round should provide better armor piercing performance, particularly at steep angles of attack.

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(6) Fuses.

The Fuse, Base Detonating, M91, currently standard, includes a tracer element. However, as apparent from the armor penetrating data given above, the performance of this type fuse against steeply sloped armor is very poor. The T150E1, Point Initiating Fuse, will replace the M91 for all rotated artillery shell. Fuses for non-rotated artillery shell of the HEAT type are to be developed under Ordnance Project TM 1-260.

(7) The Cartridge, Smoke, WP, 75mm, M311, with Point Detonating Fuse, M48A2, is now standard. Its ballistics almost match those of the HE round. However, this projectile gives poor performance, since the shell frequently fails to rupture on impact, with resultant loss of smoke efficiency.

(8) AFF Board No. 3 Project No. 2115 recommended the development of an improved smoke shell matching the new HE shell ballistically, which will replace the above round. The new shell will be of higher capacity, and having thinner walls, will be easier to rupture with a small burster.

(9) The Cartridge, Target Practice, 75mm, M309, with Point Detonating Fuse, M48A2, is now standard. It contains a black powder spotting charge.

(10) The Cartridge, Drill, Sub-Caliber, 75mm, T13 is now under development and will provide a combination drill cartridge and sub-caliber training device.

c. Fin Stabilized HEAT Shell.

OCM Item 29589 authorized a long range development project on fin stabilized projectiles for rifled and smooth bore weapons. Two projects are currently active, as follows:

(1) Picatinny Arsenal is now developing, under contract with an outside agency, a 30° expanding fin type of non-rotating HEAT Shell to be fired from a closed breech 75mm gun at an estimated velocity of 2,400 f/s. It is understood that this projectile would not be efficient in a standard 75mm recoilless rifle, since the fin area required for stabilization at supersonic velocity is greatly in excess of that needed for stabilization in subsonic flight.

(2) Aberdeen Proving Ground is supervising the development of a fixed fin, long boom type shell. This projectile is also understood to be designed for supersonic flight.

(3) A fin stabilized HEAT shell for use in current recoilless weapons would require the removal of some powder from the cartridge case in order to permit room for the fins, with a resultant loss of an estimated 100 to 200 f/s of velocity. No such round is under development at this time.

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d. Lightweight 75mm [illegible]

Preliminary design work has been done on a new 75mm Recoilless Rifle, employing a shortened cartridge case, a new breech design, and other improvements. It would have the same exterior ballistics as the M20 rifle, but would weigh approximately 75 pounds. There is some question regarding the adaptability of a fin-stabilized projectile to the shortened cartridge case, since there may be a tendency to knock off the fins as they leave the cartridge case.

3. 105mm Recoilless Weapons and Ammunition.

a. General.

OCM Item 29053 authorized the continued development of improved models of 105mm recoilless gun materiel, to include the following:

Gun, Recoilless, 105mm, T19
Carriage, Recoilless, Gun, 105mm, T47
Cartridge, HE, 105mm, T42
Cartridge, HEAT, 105mm, T43
Cartridge, Smoke, WP, 105mm, T44

b. Characteristics of Materiel:

(1)

Weight of Gun, T19	-360 pounds
Weight of equilibraters	- 64 pounds
Weight of T47 Carriage	-560 pounds
Total	-984 pounds

Muzzle velocity - 1,120 f/s
Weight of projectile - 33 pounds
Sights - both direct and indirect fire sights are to be provided.

(2) Carriages:

(a) Towed (T47)
(b) ¼-Ton Truck Mounted (T44)

(3) Gun Modifications: A breakdown type 105mm gun is also being developed under this program.

c. Ammunition.

(1) Cartridge, HE, 105mm, T42, with Point Detonating Fuse, M51A4.

(a) Characteristics as follows: Weight of complete round - approximately 49 pounds. Weight of projectile - 33 pounds. Weight of shell filler - 4.8 pounds. Maximum range - 9,415 yards. Effective bursting area - 45 yards by 7 yards. Initial fragment velocity - 3,500 f/s. Total number of effective fragments at 10 yards from the burst - 1,005.

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(2) Cartridge, HE [illegible] tonating Fuse, M91. The ballistics of this round will closely approximate those of the HE cartridge. The best available data or armor penetration is that obtained recently by this Board in limited firing of the Shell, HEAT, M67, with Base Detonating Fuse, M62A1, at a muzzle velocity of 1,250 f/s from a conventional 105mm Howitzer. (See below).

Slope of Plate From Normal (in Degrees)	Average Measured Length of Hole (in Inches)	Average Thickness of Armor Plate Defeated (in Inches)	% of Rounds Penetrating Less than ½ Average Thickness of Plate
70	1.75	.6	0
65	2.7	1.1	20
60	5.	2.5	14
55	5.25	3.0	0
50	5.4	3.5	0
45	4.9	3.5	0
40	5.25	4.0	0
0	5.5	5.5	0

(3) Cartridge, Smoke, WP, 105mm, T44. Performance of this round should be identical with that of the 105mm Howitzer smoke shell when fired at Charge 5, (1,020 f/s).

(4) Fin Stabilized HEAT Shell. The Aberdeen Ballistics Research Laboratory Memorandum Report No. 457 described the performance of a Fin Stabilized 105mm HEAT Shell, which was fired from a standard 105mm Howitzer, M2, without damage to the rifling. This non-rotating projectile penetrated 10 to 11 inches of armor and had a probable error of 1/2 mil at ranges up to 1,000 yards when fired with a muzzle velocity of about 1,500 f/s. Beyond this range accuracy fell off rapidly, apparently due to the fact that stability of the projectile deteriorated as the velocity passed through the speed of sound. There appears to be a strong possibility that a projectile of this type would be suitable for use in not only the 105mm recoilless rifle but smaller calibers as well. With relatively small loss in accuracy and velocity.

(5) "Squashhead" Antitank Shell.

(a) OCM Item 32447 authorized a research program on the "Squashhead" principle and "Squashhead" Shells, and the development of the Shell, HE, 105mm, T81, with appropriate fusing, Priority 1C.

(b) This type of projectile appears to be effective against steeply sloped armor, and secondarily against concrete and personnel. It is limited to velocities of approximately 2,500 f/s. It can be protected against by spaced armor or laminated plate.

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(c) It appears that this projectile, if found to be more efficient than other types of armor piercing shell, may be desirable for use in recoilless weapons in all calibers. The Shell, HE, 105mm, T81, with minor modifications, should be usable in the Recoilless Gun, 105mm, T19.

4. Multi-Purpose Lightweight Antitank Weapon.

a. OCM Item 31487 authorized the development of a new weapon to replace the 2.36" and 3.5" Rocket Launchers and the 57mm Rifle, M18.

b. As abstract report on the Multi-Purpose Lightweight Antitank Weapon, prepared by a civilian facility under contract with the Chief of Ordnance, has recently been received. This is in the form of a report of study. The recommendations are essentially as follows: three alternative lines of development are suggested. The essential details of each are quoted below:

"(1) 75mm Recoilless Rifle incorporating the following features:

(a) Chamber and breech formed substantially by the cartridge case.

(b) Rifled barrel to impart slow rotation to shell.

(c) Weight of rifle not to exceed 25 pounds.

(d) Fin stabilized ammunition not to exceed 10 pounds in weight.

(e) Muzzle velocity about 900 ft/sec.

(2) 75mm Recoilless Rifle firing rocket-assisted projectile and incorporating the following features:

(a) Conventional recoilless design or improved design as described in (1) (a).

(b) Rifled barrel to impart slow rotation to shell.

(c) Weight of rifle not to exceed 21 pounds.

(d) Fin stabilized ammunition not to exceed 10 pounds in weight, having a cartridge for recoilless launching and a rocket assist motor in the projectile together with a mechanism to set off the rocket shortly after launching.

(e) Average muzzle velocity as attained by rocket assist propulsion, about 900 to 1,200 ft/sec., with an initial recoilless, launching velocity of about 300 ft/sec.

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(3) 90mm Recoilless Rifle incorporating the following features:

(a) Chamber and breech formed substantially by the cartridge case.

(b) Rifled barrel to impart high rotation to shell.

(c) Weight not to exceed 45 pounds.

(d) Ammunition having conventional shape for spin stabilized shell not to exceed 15 pounds.

(e) Muzzle velocity about 1,200 ft/sec.

For all these weapons a HEAT warhead of best available design at the time of prototype construction is recommended.

It is estimated that two, three, and four years, respectively, would be required to reach pilot model stage in the first, second, and third recommended designs."

Attention is invited to the fact that it would be two years until the first pilot model can be completed.

5. Gun, 81mm, T107.

The Gun, 81mm, T107, is being developed under Ordnance Project TR 1-1035. The purpose is to develop a lightweight antitank weapon making use of the low sustained pressure principle of propulsion. As currently visualized, this weapon will fire a fin stabilized HEAT projectile from a smooth bore gun and will incorporate a gas expansion chamber in the breech.

6. Rockets.

a. The Rocket, HEAT, 2.36", M6A5.

(1) Weight - 3.4 pounds. Velocity - 265 f/s. Maximum range - 700 yards. Effective range - 200 yards. Mean radius at 200 yards - approximately 4.5 feet. Penetration of homogeneous armor at 100 yards range:

Slope of Plate from Normal (in Degrees)	Average Measured Length of Hole (in Inches)	Average Thickness of Armor Plate Defeated (in Inches)	% of Rounds Penetrating Less than $\frac{1}{2}$ the Average thickness of Plate
65	0	0	--
60	1.4	.7	56
55	1.55	.9	29
50	3.55	2.3	24
45	3.63	2.6	10
40	4.22	3.2	5
30	4.6	3.7	5
0	5.0	5.0	0

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b. Rocket, HEAT, 2.3[illegible]T

(1) Weight - 6.8 pounds. Velocity - approximately 425 f/s. Maximum range - approximately 1,350 yards. Effective range - 500 yards. Mean radius at 500 yards - approximately 2.4 feet. Penetration of homogeneous armor - 7 inches at normal impact. No data is available on penetration against sloping armor.

c. Rocket, HEAT, 3.5", M28.

(1) Weight - 8.5 pounds. Velocity - 335 f/s. Maximum range - 960 yards. Effective range - 300 yards. Mean radius at 300 yards - approximately 3 feet. Penetration of homogeneous armor at 30 yards range, based upon limited firings at Aberdeen Proving Ground:

Slope of Plate from Normal (in Degrees)	Average Measured Length of Hole (in Inches)	Average Thickness of Armor Plate Defeated (in Inches)
60	6.5	3.2
45	10.2	7.2
30	10.4	9.
0	11.	11.

NOTE: All rounds penetrated at least one-half of the average thickness of plate shown above.

d. Proposed 16 Pound Rocket and Launcher Therefor.

(1) Proposed Rocket:

(a) Weight - 16 pounds. Maximum range - 2,000 yards. Effectiv[illegible] range - 1,000 yards. Armor penetration - 10 to 12 inches.

(2) Proposed Launcher and Ground Mount:

(a) Weight - 75 pounds complete. Breaks down for parachute drop or man-carry into two pieces. Maximum weight - not over 40 pounds each. Length of tube - 90 inches (rocket to complete burning in tube).

(3) Comment: When a proposal for an Airborne Antitank Weapon was referred to this Board early in 1948, the Ordnance Office was approached informally on the subject of a rocket to meet this requirement. Preliminary design studies of rockets and launchers were made by the Office, Chief of Ordnance, and the data presented at a conference held at this Board in April 1948. The launcher and rocket suggested by the Ordnance representatives were favorably considered by this Board and we were recommended for development by AFF Board No. 3 Project No. 2106. This report has been referred to the Chief of Ordnance for comment.

It was visualized that this rocket and launcher would answer an urgent requirement for Airborne troops and would also be of great value to Infantry.

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e. Canadian Armament Research and Development Establishment Technical Memo No. 28/48, 5 August 1948, describes an interesting new type of rocket called the "Heller." It is patterned after the German "Hammer" AA rocket, and incorporates lateral vents in the rocket motor instead of the conventional rear nozzle. This design appears to offer many advantages for an antitank weapon. The primary feature is a relatively high velocity (now about 900 f/s). The rocket is non-rotating. The launcher will be somewhat heavier than that for a conventional rocket, but still lighter than a recoilless gun of equal power. This rocket is still in the initial stages of development.

DR. HEDGE - RECOILLESS RIFLES

The lightweight 57mm T66 is in the process of fabrication, the first pilot models. The remarks that Colonel Stuart made about the mechanical features of the rifle, the breech mechanism, etc., are to be interpreted as tentative in the sense we have not made or fired the designs. We have more than a reasonable expectation that the thing will work as we have laid it out, but we do not want to be required to deliver it to you people in accordance with the drawings that we now have. That is, some minor modification may be required in the machanism. Reduction in weight will be achieved by some simplification in mechanism, the elimination of parts, and by the reduction of length and diameter of the chamber slightly, with the incident increase in loading density and the shortening of the tube. We hope to take a foot or more off the overall length of the rifle, reduce the diameter of the chamber, make it conical in section, taper the chamber and make a change in the ammunition which will be largely in the cartridge case. As Colonel Stuart said we shall use a tapered cartridge case throughout rather than the cylindrical one, in order to get the necessary powder charge in the shorter overall package. The lightweight 75 is not as far along as the lightweight 57. It reached its present stage earlier in the game but its development was suspended. We are hardly farther than the very preliminary design study on the light 75. There are several possibilities on which we can work to lighten the 75. We can apply the general principles that have been used in the T66 and lighten the 75 by reducing the physical dimensions, diameter of the chamber and the length of the tube and by changing the interior ballistics slightly, increasing the loading density of the weapon without substantially affecting the muzzle energy of the piece. We hope by presently being undertaken design study on the 75 rifle to get a lighter shell out of the ammunition people. During the time it is in the rifle it serves to affect the rifle design only as a slug we have to push out of the tube of a certain length and a certain velocity. The lighter shell has poorer exterior ballistics. You are not interested in the muzzle velocity of the weapon but rather in the time of flight of the projectile between the rifle and target and flatness of the trajectory. It seems that from the overall weapon performance viewpoint it is better to raise the velocity as you lighten the shell rather than keep the velocity the same and deteriorate your time of flight and flat trajectory. We think that we can reduce the 75mm rifle to a weight of about 75 pounds, doing either one of two things, using the same shell essentially that we have now and maintaining the same muzzle velocity, or by using a lighter shell if one comes out maintaining the same muzzle energy, that is, increase the muzzle velocity which will improve the exterior ballistics at short range and won't deteriorate them at medium range. We can make the rifle probably as light as 67 or 70 pounds

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if we maintain the same muzzle [illegible] several pounds lighter. That will make the trajectory not quite flat and your time of flight will be longer at your longer ranges than the present projectile. Our hunch is that that is not the way to fix it. As I said, the fin stabilized HEAT projectile will be discussed in detail later. I might say with respect to recoilless rifles that any shell which is usable in a conventional gun is, with minor changes, usable in a recoilless rifle of comparable muzzle energy. The shell does not know whether it is fired from the conventional rifle, or gun, or from the recoilless rifle so that the shell will perform with certain pressure behind it and take on certain velocity, perform satisfactorily, and do it equally well whether its ejected from a recoilless rifle or otherwise. The selection of the particular medium in which these things are developed is largely one of expediency. There are lot more conventional guns available than there are recoilless rifles and the range of velocities and pressures that can be used for laboratory equipment is considerably larger, and it takes considerably less powder to fire each round. We don't have any region of danger behind the conventional rifle, so from the laboratory point of view it's more sensible to do at least the preliminary work on these things with the conventional weapon - put them in the recoilless rifle after the spade work has been done.

The 105 is the project that has been long with us and long inactive. As Colonel Stuart said, the ammunition is now beginning to be available. Our engineering test, which was started at Aberdeen two years ago and suspended not long after that for lack of ammunition, have been resumed. We hope the tests will go along rapidly and the 105 will be available for service test within a reasonable time. The work at Aberdeen has not progressed far enough yet for me to make a precise estimate on when we can hope to get through with that weapon and deliver it to you. In the meantime, although we do have on our books projects for developing the breakdown models of the 105 recoilless rifle, those phases of the development are essentially inoperative by agreement with the Field Forces. We have committed ourselves to the development of active new weapon types of 75mm caliber. We are doing the T21E10 breakdown 75. We are also undertaking the development of the mid-barrel joint for the 75 with the reasonable certainity that we can do it with the 105 as well. It's probable there will be no immediate need for the 75 with a barrel that is in two pieces. The barrel is a lighter part than the other two loads. The only question of shortening the length is to get the maximum length of a chunk under three feet, but if we can develop a joint in the middle of the tube of the 75, we can then give you a chance to look at it. If you want it in a 105 we can put it in. If you want a 105, that is. Not having had a firm commitment on either, the new work is then going on 75mm caliber but to that extent will be applicalbe to the 105.

I think that covers pretty well the items of existing, or minor modifications or developments, of existing recoilless rifles. I might ask if there are any questions at this stage. I am going to talk next and lastly about the multi-purpose weapon.

The type of fin stabilization, I believe, will be different for high and low, for subsonic and supersonic projectiles. A projectile that can

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be fired from a high velocity gun can be fired from a high velocity recoilless gun. If we get the light projectile we can raise the velocity. We are close to a border line region there. I don't think there is any trouble with achieving the stabilization. We know how to stabilize with fins of projectiles below sonic velocity, and also one above. The real difficulty, this scheme is slightly different and you can't use it with too great satisfaction. A projectile that is stabilized for one region can't be used in another very well. We can agree to do this, if a projectile turns up that is satisfactory in the fin stabilized projectile, we will put a recoilless rifle around it for you and one that will fire satisfactorily. The service models of our recoilless rifles are all low velocity weapons, that's true. The reason for this lies way in the background of the early history of this thing. The prime requirement, the thing that we thought would be the most useful when we started out developing these weapons, was the antitank round, and we designed the rifles to fire the antitank rounds that were available or could be developed. One was developed. When we came to the 57, 75, and 105 we took the HEAT rounds that were on deck. We built the rifles to fire them at their maximum serviceable velocities, and then we matched the other projectiles to go along with them. That is, it was the HEAT round that determined the velocity and nothing inherent in the recoilless rifle. I might say that we have experimental recoilless rifles in three calibers that we can fire with the velocity exceeding 2800 feet per second, so there is no inherent limit on the velocity that you can squeeze out of the recoilless rifle. We are not developing a rifle that will fire this ammunition or vice versa. You couldn't fire this round at 2500 feet per second and expect to get anything out of it, but we could make one right now that would be, I believe.

Colonel Lucas: Q. If you would fire a shaped charge at a higher velocity, let's say 2400 or 2500 feet per second, are there any other problems which would tend to limit the effectiveness? I'm talking about fin stabilized projectiles.

Dr. Hedge: A. There need not be, I believe. In this particular round I think there are because of the question of crush up, the action of the fuse, etc., but they are not fundamental problems. You couldn't fire this round at 2500 feet per second and expect to get anything out of it, but we could make one right now, I believe.

Colonel Lucas: Q. What is the time estimate on the fin stabilized shell?

Dr. Hedge: A. I'd rather now answer that question on ammunition as I know about those things only vaguely.

Colonel Stuart: A. We can answer that question now on the HEAT type fin stabilized shell, Sir, wouldn't you say about a year?

Mr. Taliaferro: A. I think probably in about a year we probably will have something to start on, or maybe in a little less time.

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Colonel Lucas: Q. You mean we will have a test model?

Mr. Taliaferro: A. We are actually firing a 90mm fin stabilizer shell now and that is the one that B.R.L. is working on now.

Colonel Lucas: Q. You think you will have one for this Board to test within a year?

Mr. Taliaferro: A. Whether the Board will have one in a year, I can't say. We will no doubt have one to fire ourselves, our's being an engineering test.

Colonel Lucas: Q. Your 105 breakdown, what is your time estimate on that?

Dr. Hedge: A. Well, I suspect within the year we might have the 75mm gun. We might have a 75mm prototype breakdown joint. As the job now stands, we will not, without further demand from the Army Field Forces, provide you with a breakdown 105. We have agreed, in other words, to bring the 105 to a logical conclusion which will mean keeping it in an experimental status until it has survived or failed the Service Board test in its present form.

Colonel Lucas: Q. I am assuming it comes after, how long would it take us to get one of these?

Dr. Hedge: A. If we get the 75 breakdown joint within that set time and if it's satisfactory, I would think it would take a matter of not more than six months to put it in a 105, that is, provided we prove the joint in the 75mm, or the two joints. The attachment of the barrel to the chamber is pretty well proved in the 75, so far as we are concerned with the T21E10, and after you have seen that, if it meets with your approval, there is no question that we can put that barrel chamber breakdown joint in a 105. Then put a break in the middle of the barrel to reduce the overall length and also the weight in case the tube is fairly heavy. I think if we can do that with the 75 we could put it in the 105 in six months. It's largely a manufacturing problem.

Colonel Lucas: Q. Let me put it this way, suppose this Conference here indicated a set interest in that particular project, how long would it be before we could get a breakdown model for our test, the 105?

Dr. Hedge: A. I think that estimate, the way things have gone, it will be between a year and a year and a half. That is, with the deactivation of the 105 and our continued test of that mid-barrel joint in the 75, it would now be more economical of time and money to complete the job in the 75, than to parallel with the 105 and run through it from beginning to end, which is what we would have to do if we didn't finish the job on the 75.

Colonel Lucas: Q. Did you or Mr. Taliaferro give the expected penetration of the fin stabilized 75 round and the 105 round?

Dr. Hedge: A. I didn't and I'll leave that to Taliaferro.

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Mr. Taliaferro: A. We hope, [illegible] the 3.5" rocket penetration. I would say somewhere around 10 inches on the 105; we should equal the 3.5" rocket of the 75.

Colonel Lucas: Q. There would be a very slight difference?

Mr. Taliaferro: A. A slight difference but not very much.

Dr. Hedge: One of the prime reasons we are interested in getting together with you people for discussion has been laid before you - the problem that is presented in our report by the Arthur D. Little Company of the investigation of the multi-purpose lightweight antitank weapon. I think the requirement for this weapon originated with the Board a year or two ago and since that time we got an authorization by OCM to divide the work on this weapon into two phases - an initial study of the possibilities of meeting the objectives, and the second phase the development of the actual weapon, or weapons, to meet these objectives. The first phase, which was given by contract to the Arthur D. Little Company, has been completed and their work is represented in the last report which has been delivered to your people and the recommendations summarized on page 7 of Colonel Stuart's mimeograph survey. They have suggested, or have concluded, that among the possibilities of coming close to these requirements, which Colonel Rosebaum summarized in his opening remarks, essentially we have been asked to provide the maximum performance and minimum weight among the 57mm recoilless rifle, 37mm recoilless rifle, which was then a project which never materialized into a weapon, and the 3.5 and 2.36 rocket launchers. We were asked to make the lightest of these two do the best job that the heaviest would do. The best recommendations that we can come out with, with our present scientific knowledge of weapon development, is considerably short of these objectives, as you will see in looking over all the recommendations. They have recommended three possibilities; they are predicated on slightly different chance that certain factors may be more important than others and neither they nor we are in a position to know which is more important. For instance, if you are willing to give us a long time we could do a more precise job than if you want the job done in a hurry. If you give us a long time we could lean with more confidence on the development of a spin stabilized shaped charge round. It would give something like optimum preformance. If you want us to develop the weapon immediately we will probably have to bypass the use of the spin stabilized powder charge round and use fin stabilization. So the three recommendations that they have made are: First, a 75mm recoilless rifle with an unconventional rifle design which will make the weight of the whole thing take the order of 25 pounds employing fin stabilized ammunition, and a muzzle velocity of around 900 feet per second. The second is the 75mm rifle to fire a rocket assisted projectile. That is, a booster launcher in the sense that a recoilless rifle will fire a fin stabilized projectile at the muzzle velocity on the order of 300 feet per second, and the rocket motor in the projectile will carry it on from the muzzle to an average velocity comparable to what you get from the 900 feet per second muzzle velocity. The third recommendation is the 90mm recoilless rifle, an unconventional type of mechanism designed to give the weight of the rifle not over 45 pounds. As we get farther into this we are less certain of how much weight we can save. Then if we think we can do it under that we are reasonably certain that it can be done not over

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45 pounds. The spin stabilized hollow charge round, depending on the development by the ammunition people, if they succeed in counteracting the adverse effect of the rotation, and the muzzle velocity will be 1200 feet per second, something over the velocity of sound. The advantages of these have been presented in the order in which we think we can develop them in the length of time we have. We think the first one could be done in a matter of two years, the second one in a matter of three years, the third one in probably four or perhaps more years. That's development time too, pilot models. In every case we are over the weight of performance which you asked for. The overall weapon weight we have exceeded. In no case will we have the range and accuracy which you have asked for. The last one will give you the range and accuracy of the 57. It's the heaviest of the three. In all of them the penetration will be comparable to the 3.5 and the things we would like to ask your decision on are these. Shall we undertake the development of this weapon. In which of these forms shall we undertake it? Now, the outlines as to the characteristics and remarks as to the type of breech mechanism and that kind of thing are to be considered only as tentative proposals for a line of approach. We think within the limits we have indicated and the performance limits we have specified we can make the weapon do the job you have assigned to us here. We wouldn't want to say that we will build a specific kind of breech on any one of these things. We think that the scheme of putting the venturi into the cartridge case perhaps essentially eliminating what would be recognized as a breech mechanism now, is the way of reducing the overall weight of the weapon and the small number of rounds in the ammunition. We haven't done it. It might not be the way to do it, or it might not work at all. We may have to cook up some alternative. We wouldn't want to commit ourselves definitely to do it in accordance with even our preliminary sketches, but the line of attack and the length of time it will take to develop these weapons, we think it is reasonable plan. We can start out with the directions indicated within the length of time we have allowed ourselves. We think we can come up with a pilot model or something that will be a reasonable facsimile of what we started out to come out with. They may disagree in detail, but it will function in overall considerations.

Colonel Lucas: Q. What would be the range accuracy factor on the first one - you said the last one might approach the range accuracy of the present 57?

Dr. Hedge: A. I say that it should approach it because of its muzzle velocity. The basic consideration in laying these things down was that the accurate range should not be required to be over 500 yards. I think it will exceed that in every case.

Colonel Lucas: Q. Would it reach a thousand yards?

Dr. Hedge: A. I think it would reach it, but I don't think it would be precise.

MR. TALIAFERRO - FIN STABILIZED HEAT SHELL

During the discussion this morning quite a bit of the ammunition problems have been covered. I will try to go over them generally and if any specific question we can take up in the course of discussion. Now as to actual development or any new development of this recoilless ammunition, there is not too much going on at the present time. Mainly, most of our work is in what you might call a research phase.

We have two points, or rather two lines, that we are trying to follow. One of which is to increase the penetration of the HEAT rounds and the other is to provide a round which will be stable and accurate regardless of whether we have to fire it in a recoilless weapon, or whether we have to use it in a tank gun. The two means we are trying to increase the penetration, one of which is through a new cone design and the other is through fin stabilization. The new cone design, I don't know how many of you have heard anything about it, is what we call the fluted cone. It's a series of flutes around the cone, very small, I think in the nature probably of three or four thousand in height. And by means of this fluting we can obtain about 85% of the penetration we would get if the rounds were not rotating. That means, roughly, that we can increase their penetration approximately two or two and one-half times what we now get in our regular spin stabilized recoilless shell. That is still only in the experimental research stage. We have conducted a little static firing with them. I don't know offhand whether we have done any firing with them, I don't think we have. We hope that before too long we will have some definite data on which will more than prove our theories on it. If so, a good bit of the problem is licked insofar as increasing the penetration and we will be able to meet all the requirements that have been set up at the Monroe Conference.

The other method is in the fin stabilized rounds. The question is, why do we go to a high velocity fin stabilized round on that recoilless ammunition? We are working on the theory that fin stabilization not only for the recoilless, but in case we have to put it in a tank gun, because if some of these requirements which were set up in Monroe we might have to go to a fin stabilized tank gun round in order to meet these requirements. Particularly, in a larger caliber in heavier tanks where we have got to meet some of the potential enemy heavy tanks. We can't do it with anything we have right now. I know at one point this morning the question apparently came up and we had some discussion on the range and velocity affecting penetration. Penetration is practically independent of your range except in certain cases where you get a large angle of fall particularly on the rockets. Mr. Hopkins bypassed it. You can at point blank range get less penetration than you do at some little distance from the gun.

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that is what we are doing along the research line and trying out right now principles only. Armor Research is working on the 75mm fin stabilized round. B.R.L. at Aberdeen is working on the 90mm fin stabilized. We don't know that the 75 will be an ultimate caliber, nor do we know that the 90mm will be. They are merely ready expedients which we are going into with the weapons we have available, and could determine the principle. We are also working on the T108 gun, the 81mm, the high-low gun. That will be a fin stabilized round eventually. There again is a ready weapon. We merely took a 75 and bored it out to an 81mm and made a handy gun for testing a principle. There, again, it is not a final design or final caliber by any means. We don't know what will come up. The only real development we have started is on the lightweight 75mm round. We have started Picatinny working on those and so far it's still in the thinking stage, I believe, with them. I don't believe they have any completed designs laid down, but we are starting with the HEAT round which will weigh 8½ pounds, and we will follow with the HE round and Smoke round which will weigh approximately 9 pound. They will have a muzzle velocity of 1300 foot seconds and the effective range will be, I'd say, quite a bit more than our present 75 and it will no doubt be, I should say, at least a year before we will have much of anything to fire in that. There has been some question of why we started with the HEAT round instead of the HE because I understand from Colonel Stuart there is quite a bit of interest in the HE round here. We started with the HEAT round primarily because the weight will be different between the HE and the HEAT round and we started where we knew we could get the weight first, because on the HE we have got to compromise that weight with the smoke shell. We have to make an HE shell, then fit the smoke shell ballistics. As we understood it, the antitank problem is paramount and has highest priority, so, therefore, we started with the HEAT round.

On the 57 we are not doing anything as yet. We do have the problem of developing a new series of 57. However, as pointed out this morning, the question of funds, personnel, which we don't have much of either one, and after we get through with the 75 we will no doubt start on the small caliber we are not doing anything right now on the 105. We do have the work which was conducted back here in the United States during the War and, incidentally, I have a few firings on that which more or less changed the statement which I made to you this morning on the comparison of the 105 with some of the others. We have actually fired two rounds; we got seven inches penetration at 35 degrees; got another one at 48 degrees at 7 inch penetration; we have 8-7/8" up to 56 degrees. That means that you will get a little more penetration than you will with the 3.5" rocket, probably by an inch or two with our new improvements. That makes quite a difference. Our present rounds have the steel cone. I believe most of them are fifty fifty Pentolite loaded. We have found that by going to a copper cone and with compound B loading we can just about double our present penetration.* That is a step we could take almost immediately to improve what we now have. Of course when you get the nonrotated that will be still another little step ahead, but it's farther in the distance. That, I believe, covers all that we are

*Revised to 25% increase by letter received after the conference.

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actually doing right now on the recoilless ammunition. We have a lot more work in the research stage and as yet we can't go too far on the development work until we complete our research work. What we are doing right now on the 75 is dependent a lot on the research work which is being conducted.

We are also working on a point initiating fuse and a B.D fuse which will both be graze sensitive. On our point initiating fuse we should have samples in about 60 days; on the B.D. fuse in about 30 days. That means it will probably be a little while yet before the Board will actually get some - several months yet before the Board can have them.

Colonel Sugg: Q. Is that 75?

Mr. Taliaferro: A. Well, this right now is on the 75, but the fuse will apply to any caliber.

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MR. HOPKINS - ROCKET DEVELOPMENT

The rockets that we now have standard are the 2.36, M6A5 commonly known as the bazooka and the recently standardized 3½" M28. Just to review the performance of those rockets I remind you that the 2.36 will penetrate approximately 5", from normal impact. The 3½" about 11". The only active development that we now have is 2.36, T59 type rocket which is expected to have a velocity of about 440 feet per second as compared with about 275 for the bazooka and 330 for the 3½". The accuracy of the T59 is predicted from the limited firing we have had today as about twice the accuracy of the 3½", which means about 1.2 mils probable error of dispersion against 2 mils error in the 3.5". I might add that any figures that I quote are all subject to later refinement because even on this 3.5" the number of rounds have been fired is comparatively small upon which our figures to date are based. The anticipated penetration of the T59 is about 7" of armor at normal penetration. I will mention the oblique penetration properties a little later. We have, in addition to the two standard rounds, the T59 under development, in which we are shooting for rounds for service tests about June 1949, about six months from now with our fingers crossed. Under consideration we have a development program for improvements of the 3.5" to take advantage of some of the weaknesses that have been disclosed during development of the 3.5" and some of the potentialities for improvement that have been indicated by performance of the 3.5" during test. Beyond that there has been some discussion of two other shoulder fired ground rockets the 16 pound rocket in which the anticipated weight would be about 16 pounds. This would be a round similar to the presently standard M28 but with a more powerful motor to increase the velocity and therefore the effective range to something like 2000 yards possibly as against a possible range now of say 500 yards. The greater burning distance would entail about 30 inch increase in the length of the launcher, the weight of which Mr. Jones told me we could anticipate at about 40 pounds. Would you check me on that Dr. Hedge? Does that sound reasonable? Mr. Jones has done most of the preliminary work on that. 40 pounds sounds reasonable. Then the last type of rocket which has been discussed again unofficially has not been brought to any official recognition is a possible rocket to aim at, in fact designed primarily for about 16" of armor penetration as the prime requirement, characteristic with the idea that we perhaps should go beyond and plan at least to have something in mind as to what we would do if we were confronted with a significant increase in armor to penetrate on special targets, as to have something perhaps as an ace in the hole that would not be anticipated for regular use and perhaps not for use at all but more or less on the shelf if a need did arise for a greater armor penetration than anything we have been talking about before. Some paper and design figures to get ideas of what would be involved in constructing a rocket that could be fired by a foot soldier and could be man-carried to do this result in the following approximate figures: For about 4.5" rocket with a 19 lb. total weight round of which 11 pounds will be the weight of the head with a velocity of 300 f.s. and an effective range of 500 yards. Again this is all based on application of presently known and proved principles and design and the most unattractive thing about that I think the burning distance is indicated as being about 20 feet, which is pretty obviously beyond any practical reach of the launcher length so that it would involve burning outside the launcher. The tentatively proposed answer to that problem would be to protect the gunner by some protective clothing or hood. As I say this does not sound attractive, but might be [illegible]e no better solutions in sight if such a round were r[illegible]

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To get back to review the details of the 3.5 inch, M28, it has indicated about eleven inches on the penetration at normal impact. We have recently fired some rounds at Aberdeen for angular impact that Colonel Stuart mentioned and based on preliminary information from those firings it looks as though up to about 45 degrees we still are in pretty good shape. We get about the same penetration along the path of the jet or actually about 10 1/4 inches average which means only about 7 inches through the thickness of the plate which doesn't sound too bad for the requirements for the armor penetrations. When we are dealing with 60 degree impact the penetration drops down to about an average about half that, equivalent to penetration of a 3 inch plate. Among those 10 or 15 rounds the dispersion was much greater than at any of the other angles of impact. The minimum depth of penetration of the jet was about 3.5 inches or maybe 3 1/4 inches as against an average of 6" while the maximum was ten inches. Now then again, we haven't an official report on that test yet. We only have telephone results, so we are not sure that there is any further explanation or indication for the reason for this variation, and whether there is hope, or faint hope, of achieving something more nearly the maximum as an average because that 10 inch maximum would mean about a 5" penetration through armor would make us feel pretty comfortable if we could match that 10 inches with every round or a very large percentage of rounds. That is one of the reasons that we are proposing to launch a development for improvements on the present 3.5" round. This program for improvements has reached the stage where the OCO is drawing up a list of anticipated improvements and directions to go to try to get these improvements and is checking on the funds situation which is also a very sore point. There are no funds currently available for setting up such a development project but there is some hope, I understand, that funds from Production work that where costs are lower than anticipated may be able to be transferred to cover such development projects as considered desirable. Proposed development program will be when it is drawn up, circulated as a tentative Ordnance committee action for review by the Field Forces as well as other interested agencies to add to or substract from or cancel entirely as considered desirable. I personally feel that we should improve the 3.5" Rocket as the next logical step after development of the T59, 2.36" Rocket. When we say we get about 11" penetration at normal impact with the 3.5" rocket we have experimentally and under static conditions where we will get optimum standoff and eliminate any problem of fuze delay we have gotten 14" of armor penetration pretty consistently. And that would of course give reason to hope at least that we make some improvements in either the fuze functioning or the performance of the strength or shape of the ogive which controls the standoff or in the loading of the round to increase this 11" penetration to something greater than that, and while that is probably for the present unnecessary for normal impact, it would certainly be helpful for angular impact, especially at 60 degrees. The 60 degrees impact is further reason for exploring possibilities for improving performance there because aside from any increase we can get in basic penetration figures, that is 11" in the direction of the jet. There is also the room for keeping or just maintaining even that 11" at 60 degree impact by presumably some change in construction of the ogive which we expect to hold the round fixed with respect to the plate. That is merely conjecture but at least one of the more obvious explanations of rocket penetration is the possibility that a round will skid slightly on that very grazing impact on the plate and the jet will strike the plate at a smaller angle even than the 30 degrees that it would if it detonated in position. As you also note from Colonel Stuart's figures, the recoilless rounds

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have the penetration at impact angles up to 60 degrees with very little if any falling off from the performance of normal impact. The reason for the difference in this performance of the 3.5" is not definitely known but one of the possibilities that the spin stabilized may give a gyroscopic effect that helps maintain that angle after and during the slight delay of impact. Among the other possible improvements on the 3.5" besides trying to increase the penetration particularly at large angles, are possible increase in accuracy and studying the effects of normal suspected factors on accuracy such as clearance between the round and the launcher, maintainment of accurate alignment between components of the rocket, alignment of the nozzle and the jet with the rocket axis, bending or misalignment of the fins, we shall just investigate the effect of each of the known and suspected sources of dispersion and then attempt to improve on those that appear to have the most effect on accuracy.

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MR. GUY

There are two things I would like to point out to you. First of all this rocket development is originally Canadian stolen from the Germans.

Secondly, we have only started our basic investigation but there are quite a few features I would like to point out to you. They do differ from an ordinary rocket. I was very much interested in the small rocket as the actual specifications are closely related to what we are working toward. First of all, I will show you how this does differ from an ordinary rocket. I will show you on the blackboard so you can see what we are doing. In our development we are working on the policy stated and laid down in the D. A. in England. We are trying to get a rocket that will have a high muzzle velocity. What we are trying to get is a muzzle velocity of 1400 feet per second. We felt we had better do the subsonic range of 900 feet per second. This policy statement #49 is outlined in OB 3978 in the Appendix. The British ask for an 80% chance of hitting. They have taken into consideration range estimate, the tank, human element, etc. The 57 is going to have a much better performance than the rocket. They have envisioned accuracy. We tried to get as light a rocket as possible. In it we used the best steel. It is very hard to get a very high muzzle velocity, if you are going to end up with any pay load at all. In the ordinary rocket, T59, they have tubular wires which ignite the power down through the venturi. There is a pressure gradient between the inner and outer side of this rocket tube. Those are the three main features we are trying to develop in trying to lighten it. In storage, if accidentally ignited it will not explode. Once this sealing passes the end of the muzzle the pressure, if it is not all burnt, this pressure is released and will not flashback on the chap that it firing the weapon. Ordinarily flat discs were used so that the flash can come through the center and go off and is in line with the tubular disc. Most of the work up to the present time has been in static performance. You can actually vary this burning time very easily with that type of propellant just by changing the web discs and propellant. If you have propellant break-up the surface exposed is comparatively small as compared to the middle component. We have fired shells using copper and have had better results firing them.

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